

Preventing diabetic ketoacidosis: Bridging the gap between primary and secondary care

Lesley S Mills, Christopher J Garrett

Diabetic ketoacidosis (DKA) is a life-threatening acute medical emergency, presenting with a triad of ketonaemia, hyperglycaemia and acidosis resulting from insulin insufficiency. In this article, the authors cover the current knowledge base on recurrent DKA and what services can be implemented to reduce the risk of DKA, including how primary and secondary care teams can work in close cooperation with each other and other healthcare practitioners to reduce the risk of DKA and recurrent DKA.

Diabetic ketoacidosis (DKA) is a life-threatening acute medical emergency, presenting with a triad of ketonaemia, hyperglycaemia and acidosis resulting from insulin insufficiency (Kitabchi et al, 2009) and remains the most common cause of mortality in people with type 1 diabetes under the age of 40 years (Wilson, 2012). Though usually seen in type 1 diabetes, there is an increasing incidence in type 2 diabetes, particularly in ethnic minority populations (Nyenwe et al, 2007). Presenting symptoms of DKA include polydipsia and polyuria, vomiting and abdominal pain, and altered mental state with signs of marked dehydration and, in extreme cases, Kussmaul respirations. Clinicians are trained to investigate for an underlying aetiology such as infections or drug interactions, but the most frequent cause is insulin omission (Wright et al, 2009; Randall et al, 2011). The treatment of DKA is with intravenous fluid and insulin with or without additional systemic support (Joint British Diabetes Societies Inpatient Care [JBDS-IP] Group, 2010). Technical inpatient management of the condition has been refined over the last 30 years, with the

introduction of national guidelines and use of local care pathways, leading to a decrease in length of stay for admissions and falling rates of mortality (Lin et al, 2005; Wang et al, 2006). This is likely to be further enhanced by other innovations, such as point-of-care beta-hydroxybutyrate testing (Klocker et al, 2013) and regular national audits examining adherence to guidelines, the most recent of which found that 71% of UK hospitals were following the JBDS-IP guidelines (Dhatariya et al, 2016).

Despite these improvements in outcomes, rates of DKA have increased in the last decade (Abdulrahman et al, 2013). It remains a frequent cause of mortality, particularly in the younger population (Livingstone et al, 2015), and several small studies indicate that presentation with DKA is a marker for increased all-cause mortality at 1-year and 5-year follow-up (Azevedo et al, 2014; Gibb et al, 2015).

In England, The Hospital Episode Statistics for 2014–15 approximate that there were 22 000 episodes of DKA, approximately one third of which would have been recurrent episodes (Health and Social Care Information

Citation: Mills LS, Garrett CJ (2016) Preventing diabetic ketoacidosis: Bridging the gap between primary and secondary care. *Diabetes & Primary Care* 18: 179–83

Article points

1. Diabetic ketoacidosis (DKA) remains a frequent cause of mortality, particularly in young people with type 1 diabetes.
2. People who are most at risk of recurrent DKA are adolescents and young people, with higher levels of socioeconomic deprivation, familial discord and higher levels of depression.
3. Bridging the gap between primary and secondary care can improve outcomes and reduce the likelihood of recurrent DKA.

Key words

- Concordance
- Diabetic ketoacidosis
- Joined-up approach

Authors

Lesley Mills, Queen's Nurse and Consultant Nurse in Diabetes, Warrington and Halton Hospitals NHS Foundation Trust, Warrington; Christopher Garrett is Clinical Research Fellow, Institute of Psychiatry, Psychology & Neuroscience, King's College London, London.

Page points

1. There is currently no definitive understanding of the underlying aetiological process causing individuals to be admitted for diabetic ketoacidosis (DKA).
2. Recurrent DKA is a complex mix of biological and psychological factors with an acute physical health presentation as a consequence of an underlying psychological disorder.
3. To provide a coordinated response to DKA prevention, a joined-up approach linking inpatient care to primary care is required.

Centre [HSCIC], 2015a). Furthermore, data from the National Diabetes Audit revealed that 14 240 individuals identified in the 2009–10 audit were admitted for DKA at least once during a 3-year follow-up time-span (HSCIC, 2015b).

Although increases in DKA episodes could be due to a rise in background numbers of people with type 1 and ketosis-prone type 2 diabetes, it appears that outpatient management of people with type 1 diabetes has struggled to keep step with inpatient innovations, despite the introduction of structured diabetes education and increased use of pump technology. Current UK national guidelines do not comprehensively address DKA prevention despite there being evidence for cost-effective management and interventions.

Who is at risk of DKA**Recurrent DKA**

There is currently no definitive understanding of the underlying aetiological process causing individuals to be admitted for DKA. Biological factors have previously been extensively investigated over 20 years ago when this entity was part of a syndrome referred to as “brittle diabetes” (Tattersall, 1997). The evidence so far suggests that those most at risk of recurrent DKA are adolescents and young people, with higher levels of socioeconomic deprivation, familial discord and higher levels of depression (Garrison et al, 2005; Geffken et al, 2008; Randall et al, 2011). Two small studies over the past year have indicated a cluster pattern of readmissions, perhaps indicating an acute deterioration in coping strategies or a worsening of anxiety or depressive symptoms (Byrne et al, 2015; 2016). Interviews with clinicians managing this group of patients have suggested that these presentations could be part of a self-harm process (Garrett et al, 2016).

It is, therefore, probable that recurrent DKA is a complex mix of biological and psychological factors with an acute physical health presentation as a consequence of an underlying psychological disorder.

Recognition of the psychological component is necessary to prevent further DKA episodes.

DKA and sodium–glucose cotransporter 2 (SGLT2) inhibitors

Earlier this year, healthcare professionals in the UK were sent a direct communication from the manufacturers of SGLT2 inhibitors following rare cases of DKA, including euglycaemic DKA, during treatment with SGLT2 inhibitors. This follows a warning from the US Food and Drug Administration and recommendations from the European Medicines Agency (EMA)’s Pharmacovigilance Risk Assessment Committee (EMA, 2016) to minimise the risk of SGLT2 inhibitor-associated DKA.

SGLT2 inhibitors are licensed for use for people with type 2 diabetes and are most often prescribed in primary care. Primary care staff need to be aware of who is most at risk of SGLT2 inhibitor-associated DKA (low beta-cell function reserve, during restricted food intake or severe dehydration; sudden reduction in insulin; surgery; and alcohol abuse). As well as informing individuals of the risks, blood glucose levels may not become particularly raised, so explaining the signs and symptoms of DKA and what to do if DKA symptoms develop is vital.

According to guidelines, individuals should be advised to stop taking their SGLT2 inhibitor treatment during periods of serious acute illness or infection and if they have low-food or fluid intake, experience nausea and vomiting or become dehydrated in the same way that they would be advised to temporarily stop metformin and angiotensin-converting enzyme inhibitors (PCDS, 2016).

Diabetes services and DKA management

To provide a coordinated response to DKA prevention, a joined-up approach linking inpatient care to primary care is required. Healthcare provision for diabetes in the UK has evolved in the last 5 years. Community diabetes services have developed in some areas, taking over outpatient provision, and long-

standing assumptions that type 1 diabetes should be managed within secondary care have dissipated. In many areas, repatriation of patients from secondary care is determined by age, while others use the level of complexity for pump users as a measure of whether care should be moved from secondary to primary setting. Other organisations have retained secondary care services but have up-skilled their primary care colleagues, increasing their confidence in managing more complex diabetes as exemplified by the Portsmouth diabetes service (see “Super Six model” below).

Attitudes towards patients not engaging in services have also changed. In a time of increased scrutiny and financial constraints, secondary care services are actively encouraged to discharge patients who do not attend appointments or who are not engaged with treatments. They are then returned to primary care. There is some evidence that people who experience recurrent DKA are more likely to be non-compliant to treatment or engage with services.

However, the JBDS-IP Group (2010) recommends that the specialist diabetes team should be involved in the inpatient care, discharge and follow-up of individuals admitted with DKA. It is important to ensure that communication between primary and secondary care is detailed and reaches other clinicians in a timely manner. Joint working presents healthcare professionals with an opportunity to be streamlined and successful in reaching patients. For example, Diabetes Specialist Nurses (DSNs) working with Community Psychiatric Specialist Nurses would be one way of targeting a particularly hard-to-reach group of people with diabetes (PCDS, 2011).

Laffel et al (2005) reported that it is estimated that 50% of all hospital admissions with DKA could be prevented with improved out-patient treatment and better concordance to self care. Focusing on reaching these individuals before they become unwell would reduce the number of people who are admitted to hospital. One way in which this can be improved is to consider a local strategy

whereby healthcare professionals go out and work in the community in order to strengthen the relationship between the healthcare professionals and people with diabetes.

Primary care and type 1 diabetes

The high prevalence of diabetes has necessitated a shift from the traditional specialist physician–patient relationship to GPs and practice nurses now playing a pivotal role in diabetes care. Providing shared care with specialist colleagues is advantageous as it provides the flexible treatment of patients in familiar surroundings and provision of a holistic approach. However, there are important disadvantages to this approach; no single healthcare professional takes complete responsibility, and those in primary care who are not interested specifically in diabetes can generally be less accustomed to and lack the expertise and education in dealing with such patients. These factors are particularly pertinent for individuals with recurrent DKA who are high risk, do not use insulin as prescribed and where the underlying psychological disorder is not the responsibility of a secondary care clinician or GP.

Many individuals who have recurrent DKA regularly attend hospital and tend not to be seen in general practice, so the GP may not be aware of the extent of the issue both in terms of cost to services and personal cost to the patient. However, GP involvement is often key in accessing appropriate psychological and psychiatric services, which may be necessary to treat the underlying psychological issues. Primary care is also in the perfect position to provide rapid advice on DKA, such as sick day rules and practical information on testing.

DSN and 24-hour phone line support

Much of the DSN role is providing education and support for patients and clinicians not specialised in diabetes, as well as providing a link between patient, primary and secondary care. Insulin management, technical advice on pump therapy and telephone advice, particularly at the time of crisis to avoid acute

Page points

1. The high incidence of diabetes has necessitated a shift from the traditional specialist physician–patient relationship to GPs and practice nurses now playing a pivotal role in diabetes care.
2. Primary care is in the perfect position to provide rapid advice on diabetic ketoacidosis, such as sick day rules and practical information on testing.

“Community-based management of this high-risk group depends on the commitment of secondary care diabetes teams and primary care teams specialising in diabetes working in close cooperation with other healthcare practitioners.”

hospital admissions, are key aspects of the role. Holmes-Walker et al (2007) evaluated the importance of DSN patient support through the provision of an out-of-hours diabetes telephone service for young people with type 1 diabetes. In this non-randomised, single-centre, service evaluation study, there was an increased attendance to clinic, reduced HbA_{1c}, and reduced readmissions and length of stay in hospital among individuals supported by an out-of-hours service compared to young adults who transitioned to adult services without access to an out-of-hours telephone service. It also indicated possible cost savings from reduced admissions, which covered the costs of the programme.

Community matrons

Community matrons were introduced in UK in 2005 with the remit of supporting the care of the person with a long-term condition with particular emphasis on preventing readmissions (Lillyman et al, 2009). Within NHS Birmingham East and North, the role of the assertive case manager had evolved to include working in collaboration with all specialities and disciplines in both primary and secondary care to develop individualised care (Wiltshire, 2009). Such a service is designed to support the individual with a long-term condition and complex needs and reduce the risk of hospitalisation. There is, therefore, scope for recurrent DKA to be approached by such a service. Although in some areas the role of the community matron may no longer exist, in areas such as Cheshire, the Midlands and across the south of England, the role continues to evolve to meet the needs of their local areas. Herklots et al (2015) recently identified that the matrons' role as medication prescriber was a key feature for preventing unnecessary hospital admissions.

The Super Six model

The Super Six model is a model of care developed to bridge the gap between primary care clinicians and secondary care specialists (Kar et al, 2012), enabling primary care teams to function within an extended clinical

professional domain in their community setting. It provides the GP practice with access to virtual clinics for case-based discussions and reviews of patients, audits and educational sessions. The model is also thought to have empowered primary care to manage more complex cases, underpinned with regular support from secondary care (Kar et al, 2012). There was the need to negotiate the consequential loss of hospital tariff for clinic attendance, but, in Portsmouth, discussions focussed on the balance that existed with a reduction in sessional programmed activity from the acute trust.

Conclusion

Recognition of individuals who are at high risk of recurrent DKA is relatively straightforward with modern electronic health systems, but addressing the aetiological factors in a coordinated fashion is more challenging. It is also important to ensure continuity of psychological care of high-risk adolescents with psychological problems into the young-adult period (Bryden et al, 2001). There are different models that can be used to prevent rehospitalisation and there is no “one size fits all” but recognising and addressing the psychological component is key. Some patients will benefit from telephone support, while others will need face-to-face contact with a healthcare professional either at home or in a clinic setting. It is vital to develop a trusting therapeutic relationship ensuring continued follow-up, so that when in crisis, the patient is more likely to engage than become more unwell. The healthcare professional and patient should work in partnership to develop realistic and attainable treatment goals that will foster a sense of success, self-efficacy and self-care. Community-based management of this high-risk group depends on the commitment of secondary care diabetes teams and primary care teams working in close cooperation with each other and other healthcare practitioners. ■

Abdulrahman G, Amphlett B, Okosieme O (2013) Trends in hospital admissions with diabetic ketoacidosis in Wales. *Diabetes Res Clin Pract* **100**: e7–e10

- Azevedo LCP, Choi H, Simmonds K et al (2014) Incidence and long-term outcomes of critically ill adult patients with moderate-to-severe diabetic ketoacidosis: Retrospective matched cohort study. *J Crit Care* **29**: 971–7
- Bryden KS, Peveler RC, Stein A et al (2001) Clinical and psychological course of diabetes from adolescence to young adulthood: a longitudinal cohort study. *Diabetes Care* **24**: 1536–40
- Byrne ML, Garrett C, Collins J et al (2015) Economic impact and associations of recurrent diabetic ketoacidosis in type 1 diabetes. *Diabetologia* **58**: S410–S410
- Byrne ML, Mills LS, Saunders S, Garrett CJ (2016) The economic burden and mortality of recurrent diabetic ketoacidosis: a 3 year cost analysis and mortality follow-up at a district general hospital. *Diabet Med* **33**: 183
- Dhatariya KK, Nunney I, Higgins K et al (2016) National survey of the management of diabetic ketoacidosis (DKA) in the UK in 2014. *Diabet Med* **33**: 252–60
- European Medicine's Agency (2016) *EMA confirms recommendations to minimise ketoacidosis risk with SGLT2 inhibitors for diabetes*. EMA, London. Available at: <http://bit.ly/29n40nm> (accessed 08.07.16)
- Garrett CJ, Byrne ML, Winkley K et al (2016) Is recurrent diabetic ketoacidosis a priority? Change in service organisation has diminished the perception of recurrent diabetic ketoacidosis: a qualitative study exploring experiences in management of recurrent diabetic ketoacidosis. *Diabet Med* **33**: 180
- Garrison MM, Katon WJ, Richardson LP (2005) The impact of psychiatric comorbidities on readmissions for diabetes in youth. *Diabetes Care* **28**: 2150–4
- Geffken GR, Lehmkuhl H, Walker KN et al (2008) Family functioning processes and diabetic ketoacidosis in youths with type 1 diabetes. *Rehabil Psychol* **53**: 231
- Gibb FW, Teoh WL, Graham J, Lockman A (2015) Previous diabetic ketoacidosis is associated with a significant risk of death in the following 5 years. *Diabetes* **64**: A72
- Health and Social Care Information Centre (2015a) *The Health and Social Care Information Centre, Hospital Episode Statistics for England. Admitted Patient Care statistics, 2014-15*. HSCIC, Leeds. Available at: <http://www.hscic.gov.uk/catalogue/PUB19124> (accessed 19.07.16)
- Health and Social Care Information Centre (2015b) *National Diabetes Audit 2012–2013. Report 2: Complications and Mortality*. HSCIC, Leeds. Available at: <http://bit.ly/1GjABrq> (accessed 18.05.15)
- Herklots A, Baileff A, Latter S (2015) Community matrons' experience as independent prescribers. *Br J Community Nurs* **20**: 217–23
- Holmes-Walker DJ, Llewellyn AC, Farrell K (2007) A transition care programme which improves diabetes control and reduces hospital admission rates in young adults with Type 1 diabetes aged 15-25 years. *Diabet Med* **24**: 764–9
- Joint British Diabetes Societies Inpatient Care Group (2010) *The Management of Diabetic Ketoacidosis in Adults*. NHS Diabetes, London. Available at: <http://bit.ly/2b0hAxS> (accessed 17.08.16)
- Kar P (2012) The Super Six model: Integrating diabetes care across Portsmouth and south-east Hampshire. *Diabetes and Primary Care* **14**: 277–83
- Kitabchi AE, Umpierrez GE, Miles JM, Fisher JN (2009) Hyperglycemic crises in adult patients with diabetes. *Diabetes Care* **32**: 1335–43
- Klocker AA, Phelan H, Twigg SM, Craig ME (2013) Blood beta-hydroxybutyrate vs. urine acetoacetate testing for the prevention and management of ketoacidosis in type 1 diabetes: a systematic review. *Diabet Med* **30**: 818–24
- Laffel LMB, Wentzell K, Loughlin C et al (2005) Sick day management using blood 3-hydroxybutyrate (3-OHB) compared with urine ketone monitoring reduces hospital visits in young people with T1DM: a randomized clinical trial. *Diabet Med* **23**: 278–84
- Lillyman S, Saxon A, Treml H (2009) Community matrons and case managers Who are they? *Br J Community Nurs* **14**: 70–3
- Lin S-F, Lin J-D, Huang Y-Y (2005) Diabetic ketoacidosis: comparisons of patient characteristics, clinical presentations and outcomes today and 20 years ago. *Chang Gung Med J* **28**: 24–30
- Livingstone SJ, Levin D, Looker HC et al (2015) Estimated life expectancy in a Scottish cohort with type 1 diabetes, 2008–2010. *JAMA* **313**: 37–44
- Nyenwe E, Loganathan R, Blum S et al (2007) Admissions for diabetic ketoacidosis in ethnic minority groups in a city hospital. *Metabolism* **56**: 172–8
- PCDS (2011) *Keeping people out of Hospital*. PCDS, Insight Public Affairs, London. Available at: <http://bit.ly/1hYKyev> (accessed 21.04.16)
- PCDS (2016) What do you and your patients need to know about SGLT2 inhibitors and diabetic ketoacidosis? *Diabetes and Primary Care* **18**: 97–9
- Randall L, Begovic J, Hudson M et al (2011) Recurrent diabetic ketoacidosis in inner-city minority patients behavioral, socioeconomic, and psychosocial factors. *Diabetes Care* **34**: 1891–6
- Tattersall R (1997) Brittle Diabetes Revisited: The Third Arnold Bloom Memorial Lecture. *Diabet Med* **14**: 99–110
- Wang J, Williams DE, Narayan KMV, Geiss LS (2006) Declining death rates from hyperglycemic crisis among adults with diabetes, US, 1985–2002. *Diabetes Care* **29**: 2018–22
- Wilson V (2012) diagnosis and treatment of diabetic ketoacidosis. *Emergency Nurse* **20**: 14–8
- Wiltshire L (2009) Preventing hospital admissions: case management service and diabetes. *Journal of Diabetes Nursing* **13**: 348–52
- Wright J, Ruck K, Rabbits R et al (2009) Diabetic ketoacidosis (DKA) in Birmingham, UK, 2000–2009: an evaluation of risk factors for recurrence and mortality. *Br J Diabetes Vasc Dis* **9**: 278–82